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(54) Separator plate for fuel cell

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Specification

1. Title of Invention

Separator plate for fuel cell

2. Scope of Patent Claims

1) A separator plate for a fuel cell made by laminating and pressure-molding multiple swollen graphite sheets.

3. Detailed Explanation of the Invention

(Industrial field of use)

This invention pertains to a separator plate for a fuel cell.

(Prior art)

Fuel cells produce electricity directly by electrochemically reacting the hydrogen, hydrazine, methanol and so forth of the fuel with the air (oxygen) of the oxidizing agent. They can be divided into five types, depending on the type of electrolyte: (1) alkaline aqueous solution type, (2) acidic aqueous solution type, (3) phosphoric acid aqueous solution type, (4) fused carbonate type, and (5) solid electrolyte type. Among these, (4) fused carbonate type and (5) solid electrolyte type are said to be the second generation, and are at the basic research stage. The others have been put to practical use in some special applications, but manufacturing costs are still high, and reducing these costs is the largest problem in making fuel cells popular.

The general one-cell structure used in first-generation phosphoric acid aqueous solution fuel cells is comprised of a matrix that carries the electrolyte, positive/negative electrode members, and a separator plate that partitions the fuel. The shape of the separator plate is broadly classified into a type with a thin flat plate several mm thick, and a bipolar type which has fuel and oxygen passages on one or both sides of the thin plate. For the material, airtight electrical conductivity and corrosion resistance that can sufficiently withstand the electrolyte are required. As materials that satisfy these characteristics, carbon materials and corrosion-resistant alloys are primarily offered. In the case of carbon materials, however, materials costs, cutting costs and treatment costs are high because impermeablization treatment is required after cutting the thin plate from a graphite block and cutting grooves in it. It is difficult to reduce these costs greatly and to make the impermeablized plate completely airtight against the electrolyte and fuel, and these points must be improved. Also, corrosion-resistant metal materials, for example Ti-alloy, tantalum alloy and so forth, are expensive and are difficult to cut, and they also have the problem that when they are incorporated in a battery, its weight is increased greatly.

(Purpose of the invention)

This invention provides a separator plate for a fuel cell that improves these problems and that has sufficient impermeability (airtightness), and has electrical conductivity and chemical resistance similar to carbon materials, and in addition, has a sufficiently economical price.

(Structure of the invention)

This invention pertains to a separator plate for a fuel cell made by laminating and pressure-molding multiple swollen graphite sheets.

The swollen graphite for the swollen graphite sheets in this invention is that having bulk density from 0.001 g/cm^3 to 0.02 g/cm^3, but since the strength of the molded plate is maintained only by the entanglement of the swollen graphite particles, it is desirable to use swollen graphite

that has high bulk density of 0.001–0.005 g/cm^3 as the range in which this entanglement strength is high. These swollen graphite particles are pressed alone or pressure-molded by passing them through pressure rolls to create swollen graphite sheets. The bulk density of these swollen graphite sheets is preferably 0.1–0.5 g/cm^3. The sheet thickness at this time can be appropriately selected from about 0.2 mm to several mm depending on the thickness of the separator plate.

The number of sheets laminated is calculated depending on the density and thickness of the separator plate, but it generally ranges from several sheets to several dozen sheets. Also, when molding a grooved separator plate, the shape of the sheet can be laminated in accordance with the shape of the groove as required. This laminated sheet is set in the die and held for 3–10 minutes at a molding pressure of 100–1000 kg/cm^2, and a molded body of the final shape is obtained, which is used as the separator plate. Furthermore, it is preferable if pressure molding is performed in a die heated to 100–150°C, because degassing can be performed smoothly and there tend not to be problems in detaching the molded product from the die. Degassing is performed about 2–10 times at the beginning stage of pressing, and it is desirable because it prevents blistering due to air remaining in the separator plate. The density of the separator plate obtained in this way is preferably at least 1.2 g/cm^3.

(Implementation examples)

This invention is explained in detail below by implementation examples.

Implementarion example 1

Swollen graphite of bulk density approximately 0.002 g/cm^3 (made by Hitachi Chemical Industries, trade name HGP-1) was passed through pressure rolls, and a swollen graphite sheet of thickness about 1 mm, density 0.3 g/cm^3, width 400 mm and length 400 mm was created. This sheet was cut to 100 × 100 mm, and 10 sheets of it were laminated in a 100 × 100 mm die heated to 100°C, and degassing was performed while pressing and releasing at intervals of about 50 kg/cm^2. Then it was held at a final pressure of 600 kg/cm^2 for 5 minutes, and a separator plate for a fuel cell which was a flat sheet 1.8 mm in thickness with density of about 1.7 g/cm^3 was obtained.

Implementation example 2

Ten of the 100 × 100 mm swollen graphite sheets used in implementation example 1 were put in a die heated to 150°C, and after degassing under the same conditions as implementarion example 1 with a punch having multiple grooves 3 mm in width and 2 mm in depth on one side, it was held for 10 minutes at a final pressure of 700 kg/cm^2, and a grooved separator plate as shown in Figure 1 having multiple protrusions 3 mm wide and 2 mm high on one side, with a density of about 1.7 g/cm^3, was obtained.

Implementation example 3

Using five of the 100 × 100 mm swollen graphite sheets used in implementation example 1 and six 80 × 80 mm swollen graphite sheets obtained by the same production method, three of the 80 × 80 mm sheets were each arranged above and below the five 100 × 100 mm sheets and put into a die, whose top and bottom punch each had multiple grooves 3 mm in width, 2 mm in height and 80 mm in length on their inner surface. With the grooves of the top punch and the grooves of the bottom punch perpendicular to each other, a grooved separator plate having perpendicular grooves on the top and bottom whose protrusions were shorter than the total length of the plate as shown in Figures 2 (a) and (b) was obtained under the same molding conditions as implementation example 2.

Table 1 shows a comparison of characteristics of the molded plates obtained in implementation examples 1, 2 and 3 and a separator plate obtained by cutting conventional artificial graphite (made by Hitachi Chemical Industries, trade name PD11) then soaking it in phenol resin to make it impermeable.

Furthermore, permeability in Table 1 is the value obtained by applying air pressure of 1 kg/cm^2 to one side of a test specimen 50 mm square, then measuring the amount of air leakage Δq by the water displacement method, and calculating permeability by the following formula.

$$\text{Permeability } D = \frac{\Delta q}{\Delta t} \cdot \frac{d}{s}$$

In the above formula, Δt is the pressing time (seconds), d is the thickness of the test specimen (cm), and s is the pressurized surface area (cm^2).

As is clear from Table 1, the separator plates of the implementation examples have low permeability compared to the separator plate of the comparative example, and electrical resistivity in the direction of plate thickness is lower than the target value of 100 mΩ-cm.

Table 1

	Permeability (cm^3/sec)	Molding direction (direction of plate thickness)	Perpendicular to direction of plate thickness
Implementation example 1	Less than 10^{-5}	70	0.6
Implementation example 2	Less than 10^{-5}	70	0.6
Implementation example 3	Less than 10^{-5}	–	–
Comparative example	2×10^{-4}	2.0	1.1

(Effect of the invention)

Because the fuel cell separator plate of this invention is made by laminating and pressure-molding swollen graphite sheets, it has high airtightness, and it exhibits sufficient performance for a battery material in electrical characteristics as well. Also, since it is 100% graphite, it is not attacked by chemicals such as electrolytes. In addition, since it can be integrally molded into either a flat plate shape or grooved plate shape, there are no processing costs and material loss compared to carbon materials and metal materials, and it can be provided at a practical price, whereas high cost has been a great obstacle to practical use of fuel cells in the past.

4. Brief Explanation of the Diagrams

Figure 1 is an oblique diagram of the fuel cell separator plate that is an implementation example of this invention. Figure 2 is a fuel cell separator plate that is another implementation example of this invention, where (a) is an oblique diagram, and (b) is a cross-sectional diagram along line A-A of (a).

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Figure 1

Figure 2

(a)

(b)

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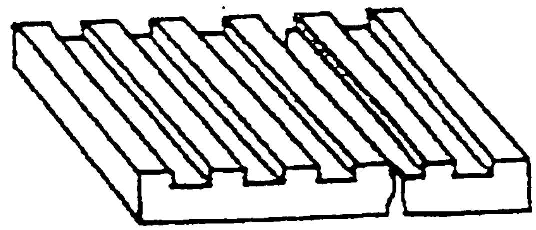

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TITLE : SEPARATING PLATE FOR FUEL CELL

ABSTRACT : PURPOSE:To provide a fuel cell separating plate having high airtightness, electric conductivity and cemical resistance similar to graphite by stacking expansion graphite sheets and press-molding them.
CONSTITUTION:Expansion graphite having a bulk density of 0.001-0.02g/cm<3> is used for forming an expansion graphite sheet. The expansion graphite powder is pressed by a press or a roller to form an expansion graphite sheet. The expansion graphite sheet having a bulk density of 0.1-0.5g/cm<3> is preferable. The thickness of the sheet is adjusted to a level of 0.2mm. to several mm.rs depending on the thickness of a separating plate. Sheets are stacked according to density and thickness of a separating plate, set in a die, then pressed at a pressure of 100- 1,000kg/cm<2> for 3-10min to form separating plate.